**Translation Document:**

**Page 2**

Safety Instructions Mobile Robotics

Last update: 23/07/2018

**Page 3**

Fundamentals

**Page 4**

General Safety Precautions (1/2)

* Safety training and the supplementary module “Mobile Robotics” have to be completed
* Work should only be carried out when
  + the required qualification is given
  + the person doing it is physically and mentally capable (not tired, inattentive etc.)
* Suitable protective clothing (safety shoes in particular) has to be worn
* At least a second person is informed and within reach
* An overview of escape paths and exists as well as the positioning of fire extinguishers and fire alarm switches has to be established
* Escape paths, fire extinguishers and fire alarm switches have to be freely accessible!

**Page 5**

General Safety Precautions (2/2)

* Rule of the thumb: Always keep an adequate safe distance from the vehicle
* Remove the vehicle trim only when necessary
* Make use of barrier tapes when carrying out functionality tests
* For operations without an authorised security software: Wheels have to rotate freely (vehicle has to be propped up)

**Page 6**

General Safety Precautions – Hall 42

* Switch on the light – the switches are in the training workshop
* Access protection roller shutter with card reader: only authorised persons have access.
* When leaving the hall, the shutter (or gate, if referring to the entrance gate of the hall) has to be closed, provided there is no other person in the hall.

**Page 7**

General Safety Precautions – Marxer Hall

* Switch on the light – the switches are next to the hall gate and further lights (?) may be switched on in the control cabinet in front of the office
* When leaving the hall, the gate has to be closed, provided there is no other person in the hall.

**Page 8**

General Safety Precautions – Hall 42

* In the test hall behind the roller shutter there is a whiteboard displaying a printout of the GBU
* Please read it before entering/working in the test area

**Page 9**

General Safety Precautions – Hall 42

* Seen from the position of the roller shutter, the emergency exit is located at the rear wall of the hall.
* The fire extinguisher and emergency button are also found there.
* Notice: The emergency button initiates an alarm call to the fire brigade and may also be used in case of a medical emergency.

**Page 10**

General Safety Precautions – Marxer Hall

* The emergency exits are located next to the main gate and opposite to the office facilities
* Several fire extinguishers are available, in the AVG test cell inter alia
* **There is no emergency button!!!**

**Page 11**

Working on Electrical Systems

Only skilled electricians are allowed to work on electrical systems

Observe the safety rules:

* Activate the system (main switch)
* Secure it against unintentional reconnection (padlock)
* Check that no voltages are present (multimeter)
* ~~Earth and short circuit~~  (energy source is a battery 🡪 protective grounding is not possible)
* Cover or block neighbouring parts under voltage

**Page 12**

Threats and Controls

**Page 13**

Electric shock when live parts are touched

Threats

Alternating voltage >50V AC or d.c. voltage >120V DC is **life-threatening**!

* Contact with charging plug/socket of the charging connector on the side
* Pantograph of the vehicle
* Soil contact plate (false conduct when loading, e.g. driving off when the charging cable is still plugged in)
* Direct contact with bare electric cables or open KSP plugs or frequency converters can be **fatal**
* Indirect contact through tools with clamps and KSP plug connectors or frequency converters can be **fatal**
* The cables marked in orange are also under voltage when the main switch is turned off

**Page 14** (see page 13)

Electric shock when live parts are touched

Threats

Alternating voltage >50V AC or d.c. voltage >120V DC is **life-threatening**!

* Contact with charging plug/socket of the charging connector on the side
* Pantograph of the vehicle
* Soil contact plate (false conduct when loading, e.g. driving off when the charging cable is still plugged in)
* Direct contact with bare electric cables or open KSP plugs or frequency converters can be **fatal**
* Indirect contact through tools with clamps and KSP plug connectors or frequency converters can be **fatal**
* The cables marked in orange are also under voltage when the main switch is turned off

**Page 15**

Electrical hazards

Threats

* Electric arcs can cause burning to the skin and eyes!
* Short circuit at the points of connection (batteries / chargers)

Controls

* Observe the safety rules when working on the vehicle
* Use appropriate tools which are insulated
* Replace faulty insulation of electrical connections
* Close the trim, covers and doors (IP)
* “Ansteuerung der Ladetrennschütze nur bei Stillstand und bei Ladebetrieb“ (no idea how this could be translated)

**Page 16**

Electrostatic discharge, ESD

Threats

* ESD for example because of friction of the drives and fan
* Errors of electronic components

Controls

* Use an antistatic wrist wrap
  + Link the ground connection of the control voltage with the chassis
  + Static charges are bypassed through the metallic chassis and the antistatic wrist wrap to the ground
* Touch open circuit boards only with antistatic wrist wraps and antistatic shoes (for example when changing the boards)
* Better: Take the circuit boards to an “Applikationsbauraum” (no idea how this could be translated)

**Page 17**

Proper handling of battery systems

* Store batteries always in a dry and cool place. Ambient temperatures up to 55°C.
* Only use
  + chargers and charging parameters that are authorised by the manufacturer.
  + battery management systems and firmware that are authorised by the manufacturer.
* Charging voltage which is too high and overcharging have to be eliminated by all means.
* Do not short-circuit. Do not cause any mechanic damage (pierce, deform, dismantle, etc.)
* Keep batteries away from small children (e.g. at family events)
* Deeply discharged lithium batteries must not be charged or used again.
* When used correctly no substances are released.
* Disposal of battery cells and electrolytes only by the manufacturer or a specialised company, not with domestic waste.
* In the case of fire/smoke and leaking electrolytes, leave the danger zone (room, hall) immediately, make an emergency call and immediately call a doctor.

**Page 18**

Overview of batteries in the vehicles

**Page 19**

Overview of batteries in the vehicles

**Page 20**

Hazardous substance Lithium-Nickel-Manganese-Cobalt-Oxidehium (no idea, how to translate that) (NMC)

Swallowing:

The substances of the battery cause severe chemical burns to the mouth, oesophagus and gastrointestinal tract. Do not induce vomiting. Do not consume foods or drinks. 🡪Immediately go to the doctor/to the hospital

Inhalation:

The substances of the battery cause irritation of the airways and lungs. 🡪Immediately go to the doctor/to the hospital

Skin absorption:

Ethylene carbonate, diethy carbonate and diemthyl carbonate cause inflammation 🡪Immediately go to the doctor

Skin contact:

The substances of the battery can cause irritation of the skin or chemical burns. The contaminated clothes have to be taken off and the skin has to be rinsed with water and soap.

Eye contact:

The contact with the open battery can cause severe irritation or burns. 🡪 Immediately lift the upper and lower eyelid and completely rinse off the chemicals with water (min 15 minutes) and after that go to the doctor

**Page 21**

Thermal danger

Threats:

* Touching electronic parts on circuit boards can lead to minor burns because these components can acquire high temperatures of up to 85°C. Also included in this category are cooling elements for example of DC converters or traction converters.
* Particular caution has to be taken in the case of drive motors as their enclosure can acquire a temperature of more than 100°C.

**Page 22**

Thermal danger

Controls

* Avoid contact
* Switch off vehicles and allow them to cool down before touching
* Whenever possible, do **not** remove the coverage

**Page 23**

Electromagnetic fields

* Can cause severe dysfunctions with pacemakers!
* Components of prototype vehicles often have not been tested by a EMV-Test
* Electromagnetic radiation is caused in particular by:
  + Final stages of the traction converters (KSP-Module/cooling element)
  + Voltage converters (DC/DC converter)
  + WLAN antennas (Accesspoint)
  + Radio boards and –antennas for remote controls (Pika, Nemo, HBC,…)

Controls

* When wearing a pacemaker, do not work on the vehicle
* Keep distance

**Page 24**

Becoming trapped in the wheel from up or down

Controls

* Wear safety shoes
* If possible, do not remove the coverage
* Only reach into or under the vehicle when the vehicle is switched off (switch off the main switch) and do this with the utmost caution

**Page 25** (see page 24)

Becoming trapped in the wheel from up or down

Controls

* Wear safety shoes
* If possible, do not remove the coverage
* Only reach into or under the vehicle when the vehicle is switched off (switch off the main switch) and do this with the utmost caution

**Page 26**

Notice – Switching off the KMP 600

* The KMP 600 is not switched off by turning the main switch off but by removing a plug connector
* Accessible from outside, see picture
* No qualification as electrician is required

**Page 27**

Pulling in/ Capturing/ Rubbing of Fabric/ Clothes/ Hair

Controls

* Wear tightfitting clothes and safety shoes, take off your jewellery, cover/tie long hair
* If possible, do **not** remove the coverage
* Only reach into or under the vehicle when the vehicle is switched off (switch off the main switch) and do this with the utmost caution
* Keep distance from rotating parts

**Page 28** (see page 27)

Pulling in/ Capturing/ Rubbing of Fabric/ Clothes/ Hair

Controls

* Wear tightfitting clothes and safety shoes, take off your jewellery, cover/tie long hair
* If possible, do **not** remove the coverage
* Only reach into or under the vehicle when the vehicle is switched off (switch off the main switch) and do this with the utmost caution
* Keep distance from rotating parts

**Page 29**

Getting caught in the lifting system

Controls

* Be careful with lifting movements
  + Speed of the lifting movement 50 mm/s (KMP1500) is by far quicker than in the case of ServiceAGV (Boeing Project) for example
* If possible do not remove the folding bellows and/or coverage
* Keep distance and do not intervene

**Page 30**

Getting caught in the lifting system

Controls

* Be careful with lifting movements
* If possible do not remove the folding bellows and/or coverage
* Keep distance and do not intervene

**Page 31**

Platform/Arm of the robot: clamp, squeeze, collision, being run over

Threats

* Unexpected movement because of
  + Software error
  + Wiring error
  + Faulty controlling system of the electronics assembly
  + Dysfunction caused by a deficient IP protection (e.g. parts that fall down into the electronics assembly)
  + On sloping terrain: opening of the brakes or failure of the holding brake
* Breakdown, error of the safety function or missing safety function (emergency stop, safety laser scanner in particular)
* During transport:
  + Unsecured transport for example in a switched-on state and when brakes are open
  + Breaking or tearing off of the towing or transport device

**Page 32**

Platform/Arm of the robot: clamp, squeeze, collision, being run over

Controls

* Keep sufficient distance, inform other people
* Before operation: Make sure that an authorised security software is installed
* Check the emergency stops for proper functioning
* Check the protective fields for proper functioning with an object, **not** with your body
* Particular caution with prototypes
* Preferably do not remove the coverage to avoid electric failures
* Transport only by qualified personnel
* Observe appropriate protection when transporting
* Particular caution and distance on steep terrain/when driving on a ramp

**Page 33**

Platform/Arm of the robot: clamp, squeeze, collision, being run over

Overview of emergency stops

* KMP 200/KMR iiwa: Two emergency stops in opposite corners of the vehicle
* KMP 1500: Four emergency stops one in each corner of the vehicle

**Page 34**

Platform: clamp, squeeze, collision, being run over

Overview of emergency stops

* **Attention!**

The KMP 600 has no emergency-stop button on the vehicle

Remote controlling KMP 6000

Automatic operation: Behind the safety fence with bumper on the floor Wireless emergency stop button at the door panel with FNA

Manual operation: With wireless remote control, emergency stop and giving of permission inclusive

**Page 35**

Platform/Arm of the robot: clamp, squeeze, collision, being run over

Overview of emergency stops

* LTC2 K2 Two emergency stops, one at each end of the vehicles

**Page 36**

Platform/Arm of the robot: clamp, squeeze, collision, being run over

Overview of emergency stops

* Jay wireless remote control (KMP 200/KMR iiwa and KMP 1500)
* SmartPad (KMP 200/KMR iiwa and KMP 1500)
* Remote control KMP 600

Attention: The emergency stops of the remote controls and hand-held devices only work in case of an active connection and an appropriate mode of operation

**Page 37**

Danger of Collision or Crushing in the Context of Lifting / Loading

Threats

* Lifting element can knock people
* Cargo can knock people when it is loaded
* Crushing between cargo and KMP through loading
* Crushing between walls/pillars and KMP/cargo
* **Attention**: protective fields of the laser scanners can be too small even in the case of an authorised security software!

Controls

* Before operation: Examination and adjustment of the protective fields where applicable
* If possible, move/ lift load in a barricaded area

**Page 38**

Danger of Collision or Crushing in the Context of Lifting / Loading

Threats

* Lost cargo can harm people

Possible Reasons

* Different parts of the lifting system are not moved synchronously
* High speed (braking) acceleration (in particular when cornering)
* Improper fastening of the load

Controls

* Fasten the load adequately, for example with belts or fix it on the threaded hole
* Wear safety gloves
* Keep distance
* If possible, move/ lift load in a barricaded area

**Page 39**

Danger of cuts

Threats

* Cutting edges: there are many zinc-plated, laser-cut holders and metal parts
* Cutting edges may not have been deburred yet (prototypes in particular)
* Cover may not be able to close permanently when development activities are going on

Controls

* Particular caution when vehicle has been opened
* preferably wear safety gloves when working on the open vehicle

**Page 40** (see page 39)

Danger of cuts

Threats

* Cutting edges: there are many zinc-plated, laser-cut holders and metal parts
* Cutting edges may not have been deburred yet (prototypes in particular)
* Cover may not be able to close permanently when development activities are going on

Controls

* Particular caution when vehicle has been opened
* preferably wear safety gloves when working on the open vehicle

**Page 41**

Moving means of transport/ work equipment

Threats

* collision with KMP, protruding load or robot arms

Controls

* Keep distance
* Wear safety gloves when working on the vehicle
* Protection fence so that visitors are prevented from entering the grounds
* Preferably set up a barrier or use a protection fence. Security fences are for example available in the adjacent area of hall 42 (in front of the roller shutter on the right)

**Page 42**

Loss of stability, rolling over of the vehicle

Possible reasons

* Improper loading, wrong fastening of the loading
* Incorrectly set prototype
* A deceleration ramp which is too strong
* Running over objects (especially when they are run over only on one side)
* Improper use on sloped planes

Controls

* Give attention to proper loading
* Keep the driving surface free from objects and keep it flat
* Particular caution when driving on a ramp
* Particular caution with unreleased software
* Keep distance

**Page 43**

Fractures in the building components

Possible reasons

* Overloading
* Wrong construction (not clear what is meant here) (prototypes)
* Faulty purchased parts (lifting unit)
* Arm breaks off application plate (e.g. as a consequence of corrosion)

Controls

* Before operation, do a visual inspection for corrosion, cracks, fatigue of material at critical points
* Keep distance

**Page 44**

Falling, Slipping, Stumbling (Sturz and Absturz are identical in English)

Threats

* Falling from the vehicle
* Stumbling over exposed cables (e.g. SmartPad, charging cable)
* Stumbling over vehicle, Bodenladekontakt (no idea, how this could be translated)

Controls

* No transport of people on AVG!
* No climbing/stepping (depending on the size of the vehicle) on the vehicle
* Tidy up and do not leave any obstacles on the floor
* Signal tape on the floor around the charging contacts

**Page 45**

Noise

An excessive noise level can

…be dangerous to health

…be a psychological burden

Threats

* signal generators (e.g. a horn,…)
* driving noise in the company
* other disturbing noises (not through the AVG, e.g. noise on a construction site)

Controls

* Keep distance
* Keep the duration of noise exposure short
* Wear ear protection in case of an excessive noise level
* Observe warning and information signs

**Page 46**

Noise

Because of an excessive noise level

* other important signals may be missed
* communication between staff members may be disturbed

Sources of danger

* signal generators (e.g. a horn,…)
* driving noise in the company
* other disturbing noises (not through the AVG, e.g. noise on a construction site)

Controls

* Particular caution
* If possible, turn off other noises which are disturbing

**Page 47**

Optical radiation

Threats

* Optical radiation can harm the eyes and the skin
* Possible sources of danger
  + When you look into the signal transmitter of the remote control of the AGV
  + When you look into the laser scanner of the AG

Controls

* Particular caution
* Do not look directly into the signal transmitter
* SICK S300/S3000 are lasers of the device category 1

**Page 48**

Conditions of the working environment

Potential threats

* Temperature (too hot, too cold)
* Illumination (too dark, too bright)

Controls

* Working areas are already sufficiently illuminated and air-conditioned
* If not: Report and cease work on site

**Page 49**

Means of Escape

Threats

* Missing means of escape in a case of emergency / fire / in risky situations

Controls

* Before starting work, get informed about escape routes or take a look at your environment and orientate yourself
* Keep all walking paths, the escape routes in particular, free of obstacles.
* In the case that an obstacle may not be removed, inform your superior

**Page 50**

Sufficient Space

Threats

* Increased risk of collisions/bumps in confined space
* Possibly an non-ergonomic body posture

Controls

* Maintain order in the working area, e.g. office hall 42, office “Weltbildhalle”
* Drive vehicles only in areas with sufficient space, keep distance to the working place/desk, watch out for alternative routes
* When the working environment is perceived as restricted, inform your superior

**Page 51**

Strenuous dynamic work on the vehicle

Threats

* Physical harms (e.g. back problems) because of lifting/pulling/moving heavy loads wrongly
* Falling/tilting parts (bumps, bruises)

Controls

* Observe the information about the correct way of carrying and lifting given in the general safety instructions
* Don’t carry heavy loads on your own, e.g.
  + Charging device
  + Battery system (when replacing)
  + Laboratory measurement instruments
  + Coverage of the vehicle

**Page 52**

Strenuous dynamic work on the vehicle

Further controls

* If necessary, make use of lifting gear/ transport aid/ a crane (may only be used by trained and authorised staff!)
* The vehicle may only be propped up and lowered by trained staff
* Pulling and towing of vehicles with open brakes: Has to be done with an appropriate number of people or a suitable towing vehicle (qualified driver)